

Sensitivity analysis of climate change risk assessment

Study of parameters variation in hazard indicators

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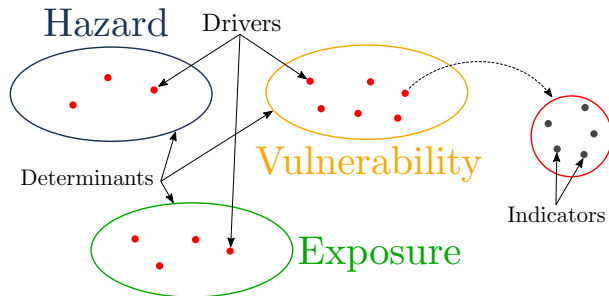
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Midterm discussion, 4 July 2024

- ▶ Risk: potential for adverse consequences for human or ecological systems [...]

Definitions

- ▶ Risk: potential for adverse consequences for human or ecological systems [...]
- ▶ Climate Change Risk Assessment (CCRA)



The problem

- ▶ The choice of indicators is arbitrary

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- ▶ The choice of indicators is arbitrary
- ▶ Analysis of the sensitivity of indicators to a change in value of their parameters, for **drivers** within the **hazard** determinant

► Torino Airport

Case study

- ▶ Torino Airport
- ▶ Hazard drivers: heat wave, heavy precipitation

- ▶ Climatological baseline: ERA5¹
- ▶ Climate projections: NEX-GDDP-CMIP6²

¹Hersbach et al., *ERA5 Hourly Data on Single Levels from 1940 to Present*.

²Thrasher, Wang, Michaelis, and Nemani, *NEX-GDDP-CMIP6*; Thrasher, Wang, Michaelis, Melton, et al., “NASA Global Daily Downscaled Projections, CMIP6”.

- ▶ Organisation: European Centre for Medium-Range Weather Forecasts
- ▶ Data type: reanalysis
- ▶ Spatial coverage: global
- ▶ Spatial resolution: $0.25^{\circ} \times 0.25^{\circ}$
- ▶ Temporal coverage: 1940-present
- ▶ Temporal resolution: hour

- ▶ Organisation: NASA Earth Exchange
- ▶ Data type: statistically downscaled bias-corrected climate projections
- ▶ Spatial coverage: global
- ▶ Spatial resolution: $0.25^{\circ} \times 0.25^{\circ}$
- ▶ Temporal coverage: 1950-2100
- ▶ Temporal resolution: day
- ▶ Historical period 1950-2014, projection period 2015-2100
- ▶ Model: EC-Earth3
- ▶ Scenario: SSP1-2.6, SSP2-4.5, SSP5-8.5

- ▶ Box of 3×3 grid points centred at the coordinates of the airport

Temporal domain

- ▶ Baseline period: 1994-2023
- ▶ Time horizons: 2021-2040, 2051-2070, 2081-2100

1. Select indicators:

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- ▶ maximum n -days precipitation amount (window size)

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 - ▶ heat wave frequency (tasmin threshold, tasmax threshold, window size)
 - ▶ maximum n -days precipitation amount (window size)
2. Fix exposure and vulnerability from literature
3. Evaluate risk following the guidelines

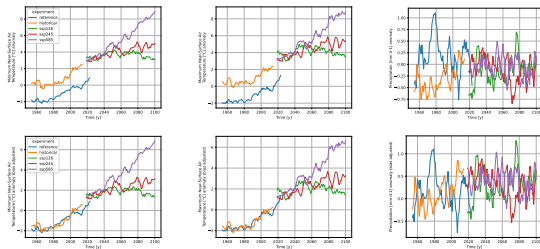
$$r = r(\mathcal{H}, \mathcal{E}, \mathcal{V}) = r(H, E, V) = \frac{w_H H + w_E E + w_V V}{w_H + w_E + w_V} = c_0 + c_1 H \quad (1)$$

Preprocessing

1. Regrid ERA5
2. Aggregate ERA5 at daily frequency
3. Align NEX-GDDP-CMIP6 timestamps

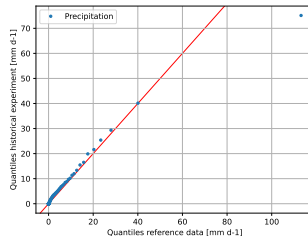
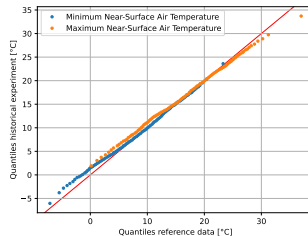
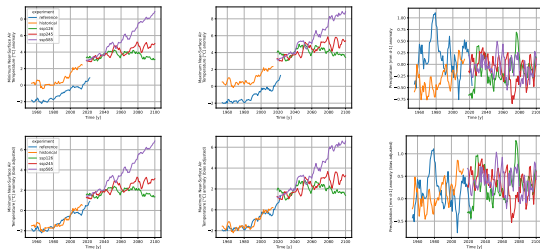
Preprocessing

1. Regrid ERA5
2. Aggregate ERA5 at daily frequency
3. Align NEX-GDDP-CMIP6 timestamps
4. Bias adjustment



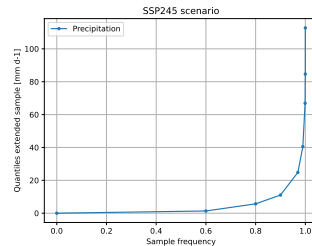
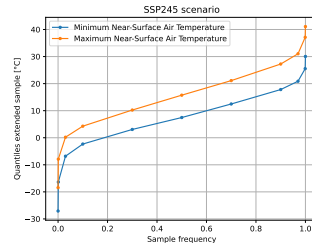
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Evaluation of hazard indicators

1. Define intervals of parameter values



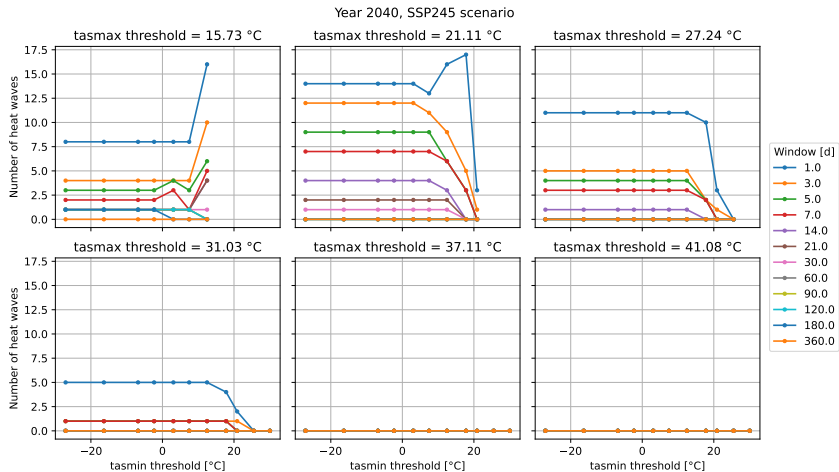
Evaluation of hazard indicators

1. Define intervals of parameter values
2. Spatial aggregation

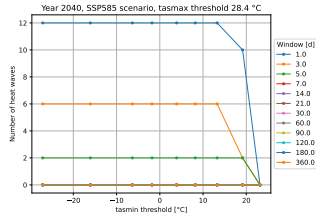
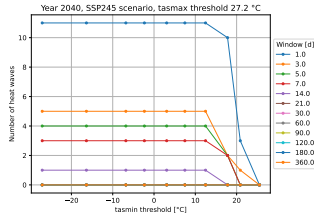
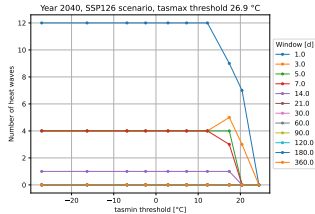
Evaluation of hazard indicators

1. Define intervals of parameter values
2. Spatial aggregation
3. Temporal aggregation

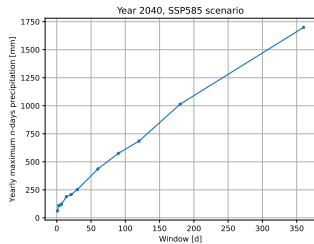
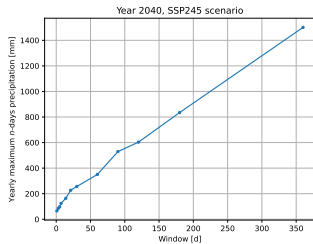
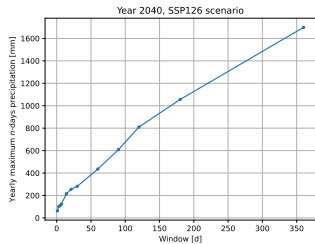
Heat wave frequency – Fixed scenario



Heat wave frequency – Fixed tasmax threshold



Maximum n -days precipitation amount



Next steps

- ▶ Extend analysis to other indicators for each hazard driver
- ▶ Extend analysis to Bologna's and Ciampino's airports
- ▶ Sample intervals specifically for the location of interest
- ▶ Normalise indicators
- ▶ Evaluate risk with non-linear relations among hazard indicators and among determinants
- ▶ Evaluate uncertainty (multi-model ensemble)